Pelagic Seabird Population in Dixon Entrance

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ABSTRACT

Vermeer, K. and L. Rankin 1985. Pelagic seabird population in Dixon Entrance. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 65 iii + 22p.

Marine bird surveys were conducted from oceanographic vessels in Dixon Entrance during May and July 1981; May, June and July, 1983; and January, April and October 1984. These surveys yielded the following values of pelagic bird densities per 100 km^2: 20 birds in January; 70 in April; 80 to 370 in May; 70 in July; and 30 in October. Standing stock of seabirds was highest in May. Ancient Murrelets (Synthliboramphus antiquus) and Cassin's Auklets (Ptychoramphus aleuticus) comprised most of the standing stock, perhaps since they are the most important species nesting in the region. Ancient Murrelets stage by the tens of thousands near their colonies, and thus would be particularly vulnerable to oil spillage during this time. Recommendations are made that 1) no offshore drilling take place in the vicinity of colonies during the nesting period, 2) systematic seabird surveys be conducted before drilling, and 3) preferred feeding localities be investigated.

Key words: marine birds, Dixon Entrance

RÉSUMÉ

Vermeer, K. and L. Rankin 1985. Pelagic seabird population in Dixon Entrance. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 65: iii + 22p.

Des relevés d'oiseaux de mer ont été effectués dans l'entrée Dixon à partir de navires océanographiques. Les relevés ont été réalisés en mai et juillet 1981, en mai, juin et juillet 1983 et en janvier, avril et octobre 1984. Ces inventaires ont permis de déterminer les densités d'oiseaux pélagiques suivants par 100 km^2: 20 en janvier, 70 en avril, de 80 à 370 en mai, 70 en juillet et 30 en octobre. La population d'oiseaux de mer était la plus élevée en mai. Elle était surtout constituée d'alques à cou blanc (Synthliboramphus antiquus) et d'alques de Cassin (Ptychoramphus aleuticus), probablement parce que ces deux espèces sont les principales à nicher dans cette région. Les alques à cou blanc se regroupent par dizaines de milliers à proximité de leurs colonies de sorte qu'elles seraient particulièrement vulnérables à un déversement d'hydrocarbures pendant cette période. Les auteurs recommandent: 1) l'interdiction du forage offshore à proximité des colonies au cours de la période de nidification; 2) la réalisation de relevés systématiques avant les forages, et 3) la réalisation d'une étude des aires d'alimentation préférentielles.

Mots-clés: oiseaux de mer, entrée Dixon

INTRODUCTION

Little is known about pelagic bird populations in Dixon Entrance. Savard (1979) conducted a few offshore surveys by airplane there in autumn and winter, but observed only a small number of birds. Because of the scarcity of data, shipboard surveys of pelagic birds were carried out in Dixon Entrance - on an opportunistic basis - during 1981, 1983 and 1984. A major incentive for conducting those surveys is the possibility that drilling for offshore oil and gas will take place in Dixon Entrance within the near future. Oil spillage poses a more serious threat to seabirds than to other marine organisms and has already claimed hundreds of thousands of bird victims on the world's oceans (eg. Vermeer and Vermeer 1975).

Dixon Entrance is a semisheltered body of water bounded by southern Alaska, northern Queen Charlotte Islands, Hecate Strait, and the open Pacific Ocean (Fig. 1). The region has been arbitrarily divided into three sections (Fig. 1): the exposed mouth and the more sheltered channel and east sections. (Some of the different surveys presently discussed were conducted in only one or two sections; pelagic bird populations may vary between sections.) We determined densities and standing stock of pelagic birds in Dixon Entrance in different months of the year by applying the same methods used by Vermeer and Rankin (1984) to determine those parameters in Hecate Strait and Queen Charlotte Sound and on the west coast of the Queen Charlotte Islands. The present investigation complements that of Vermeer and Rankin (1984). With the completion of the observations in Dixon Entrance, all waters surrounding the Queen Charlotte Islands have been surveyed once. Further and more detailed investigations are, however, necessary for a better understanding of the seasonal distributions and movements of pelagic birds in Dixon Entrance.

METHODS

The Dixon Entrance sections surveyed for pelagic birds are delineated in Fig. 2. Table 1 provides, for each section, the date, the number and total lengths of the associated transects. The areas of the three sections are also given and were calculated by planimeter from hydrographic charts.

Observational methods were essentially those used by Vermeer and Rankin (1984). Transects were carried out only when the ship was travelling during daylight. The bridge of the ship served as the point of observation. Generally, the sea was scanned with 7x35 binoculars in a 180° horizontal "field" centered on the ship's bow and to the right and left. However, if the observer faced strong sunlight, a 180° field was scanned with the sun at his or her back. Birds which approached and followed the ship, such as Larus spp. and Diomedea nigripes, were counted only once and instantaneously, for each transect. However, when three consecutive transects were surveyed, ship followers were counted once. Birds within 1 km of the mainland were not recorded. The species and number of all birds viewed during transects were recorded. Unidentified birds, as well as birds identified only to genus, were also noted. Because of the difficulty of counting numbers of birds in large flocks, only estimates were made in such cases. No differentiations were made

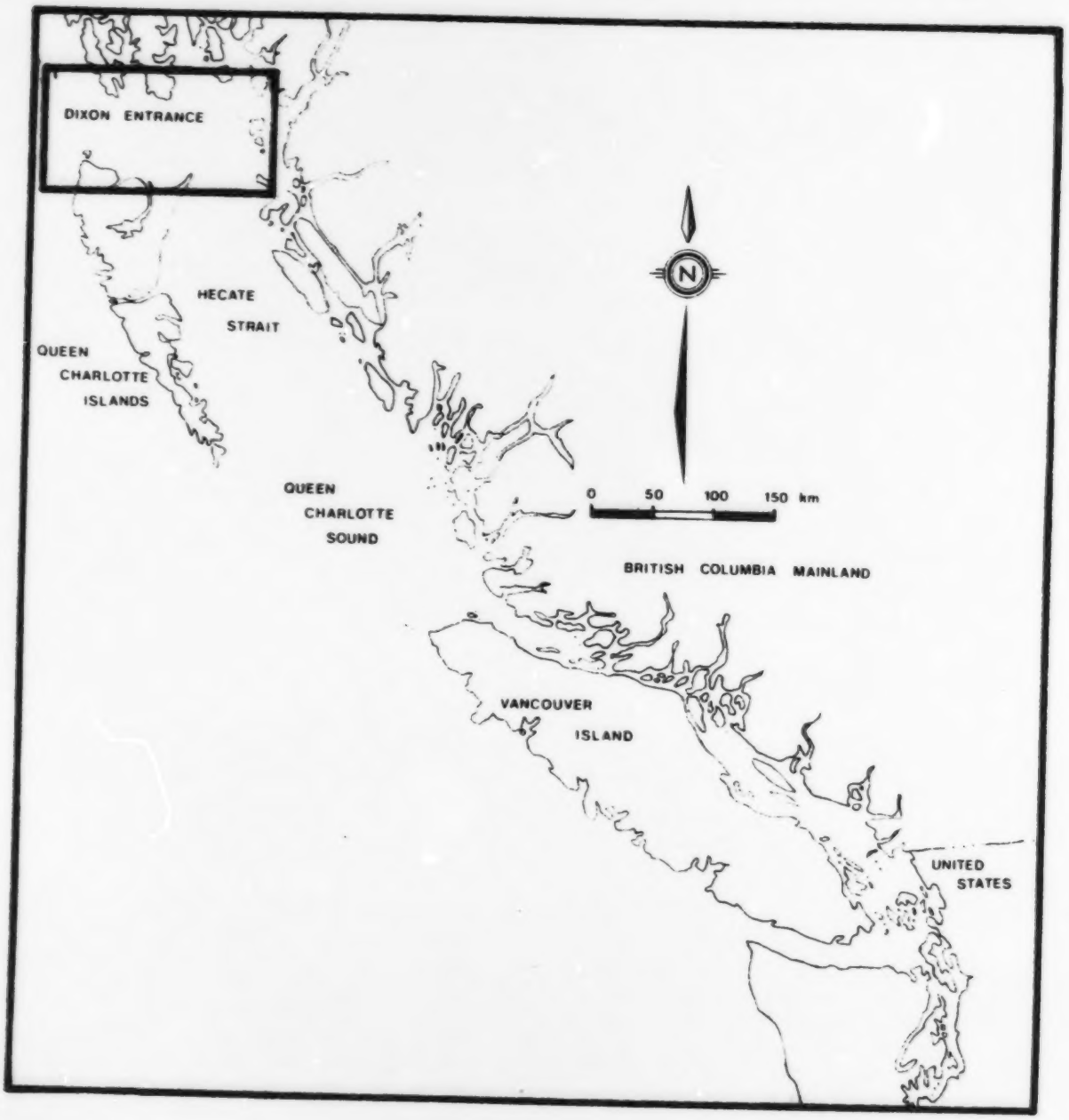

Figure 1. Survey region: Dixon Entrance on the British Columbia coast.

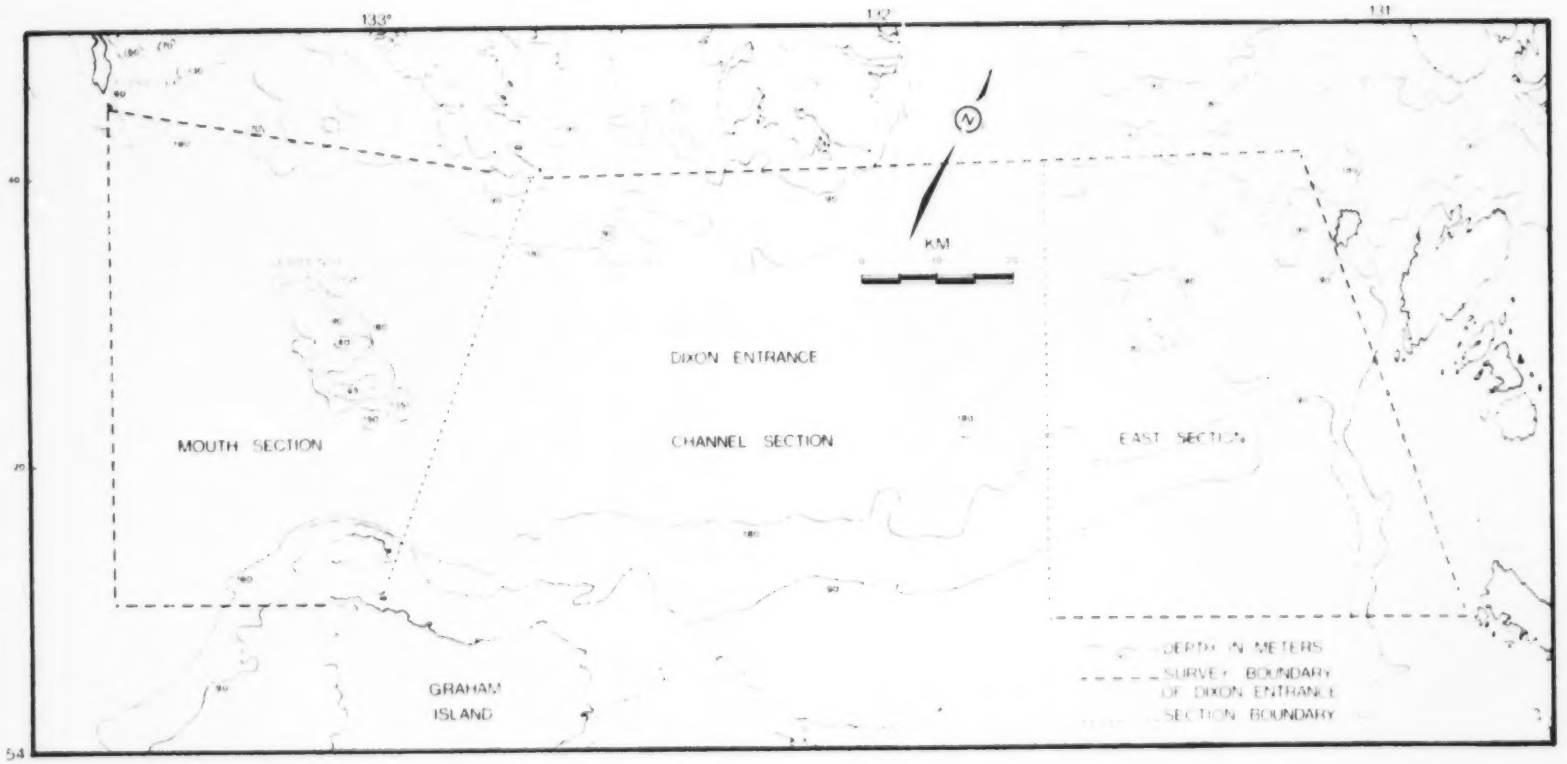

Figure 2. Location of designated mouth, channel and east sections of Dixon Entrance. Waters within 1 km of the land are not included within section boundaries.

Table 1. Number and total length of transects surveyed in different sections of Dixon Entrance (areas of sections in parentheses).

Locations and times of surveys	Number of transects	Total length of transects (km)
Mouth section (2500km^2)		
15, 18, 20-21 April 1984	32	111
30-31 May 1981	60	119
1-2 July 1981	48	95
15, 19 October 1984	20	76
Channel section (4900km^2)		
20-21 January 1984	31	74
14-21 April 1984	69	254
8 May 1983	40	125
10-11 July 1983	16	61
16, 20, 25-26 October 1984	50	185
East section (2500km^2)		
14, 16 April 1984	17	69
15 June 1983	18	51
10 July 1983	12	49
21, 27 October 1984	29	98
Total number and lengths of transects	442	1367

between flying and swimming birds. The location of the vessel at the beginning and at the end of each transect was recorded, as were distance travelled, direction of travel and the speed and direction of the wind. Transects were conducted for ten-minute periods whenever ship movements and weather permitted.

Observations were carried out during May and July 1981, May, June and July 1983 and January, April and October 1984 along transects shown in Appendix Fig. 1 - 5. Three research vessels, the CSS Parizeau,, the G.B. Reed and a chartered fishing vessel were involved; each vessel carried one observer. Five different observers contributed to the surveys. In all, 422 were carried out with a total distance of 1367 km.

Density and standing stock of seabirds were calculated by means of Sanger's method (1972), as modified by Vermeer and Rankin (1984).

RESULTS

1. Overall trends of seabird numbers

In all three sections, the greatest number of seabirds were observed in spring (April/May). Smaller numbers were seen in summer (June/July) while in autumn (October) birds were relatively abundant in only the east section of Dixon Entrance (Table 2). Fewer birds were seen in the one survey occurring in January than at any other time of the year. Ancient Murrelets (Synthliboramphus antiquus), Cassin's Auklets (Ptychoramphus aleuticus), Rhinoceros Auklets (Cerorhinca monocerata) and Sooty Shearwaters (Puffinus griseus) were most numerous in spring, particularly in the "mouth" section. Large gulls, specifically Herring Gulls (Larus argentatus), were numerous in October, while White-winged Scoters (Melanitta fusca) were abundant in April, in the more sheltered east section.

2. Species diversity, occurrence and density

Loons were more frequently observed in spring (April/May) and autumn (October) than at other times in all sections (Table 3). Of a total of 94 loons seen, 6 were Common (Gavia immer), 42 Pacific (G. pacifica), 3 Red-throated (G. stellata), 5 Yellow-billed (G. adamsii) and 38 were unidentified loons.

Black-footed Albatross (Diomedea nigripes), the only albatross species encountered, occurred mostly in the Entrance mouth. Sooty Shearwaters were common throughout Dixon Entrance, but none were sighted in January. Only one Pink-footed Shearwater (Puffinus creatopus), which has been included with the Sooty Shearwaters in Tables 2 through 7, was seen in Dixon Entrance. The Northern Fulmar (Fulmarus glacialis) was mostly seen in July and October, but only occasionally or not at all at other times. Fork-tailed Storm-Petrels (Oceanodroma furcata) commonly occurred in June and July; none were seen in January or April. Leach's Storm-Petrels (O. leucorhoa) were noted only occasionally in each of the three sections.

Table 2. Numbers of marine birds observed in the three sections of Dixon Entrance, 1981-1984.

Bird categories	Mouth				Channel					East			
	Apr 84	May 81	July 81	Oct 84	Jan 84	Apr 84	May 83	July 83	Oct 84	Apr 84	June 83	July 83	Oct 84
Gaviidae (loons)	3	27	3	8	0	24	6	0	14	0	1	0	8
Diomedeidae													
Black-footed Albatross	7	16	23	2	2	0	0	3	4	0	0	0	1
Procellaridae													
Sooty Shearwater	24	811	17	41	0	69	115	18	14	19	1	36	85
Northern Fulmar	0	0	20	5	0	0	3	24	15	0	0	10	13
Hydrobatidae													
Fork-tailed Storm-Petrel	0	71	84	1	0	0	2	4	30	0	17	86	0
Leach's Storm-Petrel	0	0	0	1	0	0	1	0	11	0	0	1	0
Phalacrocoracidae (cormorants)	1	4	5	2	0	3	0	0	6	5	2	0	0
Anseriformes (mostly White-winged Scoters)	0	1	0	17	0	23	17	0	127	850	1	0	21
Scolopacidae (shorebirds)	0	5	5	0	0	1	12	8	0	0	0	8	1
Laridae													
Glaucous-winged Gull	7	5	23	0	5	29	9	0	15	8	5	5	4
Herring Gull	79*	42	38	50	4	87	44	16	155	16	43	12	115
Thayer's Gull	2			5	3	10			4	4			0
Black-legged Kittiwake	0	0	0	7	1	0	21	0	24	0	2	0	110
Unid. large gulls	1	0	0	15	3	6	0	0	21	11	5	0	280
Miscellaneous gulls	0	0	0	1	2	14	0	3	0	0	0	0	4
Alcidae													
Common Murre	12	32	0	1	1	12	8	20	20	27	4	7	52
Thick-billed Murre	0	0	0	0	0	0	0	0	0	0	0	0	7
Rhinoceros Auklet	36	283	60	7	0	29	42	11	0	45	19	20	0
Cassin's Auklet	42	251	55	1	0	3	22	15	0	0	0	2	27
Ancient Murrelet	155	844	34	0	0	329	267	11	0	209	0	0	0
Unid. and misc. alcids	41	2	1	18	0	30	8	3	3	7	4	2	7
Unid. and misc. birds	3	0	1	6	0	0	0	2	0	0	1	3	0
Total number	417	2394	369	188	21	669	577	138	463	1201	105	192	735

* Herring and Thayer's gulls are grouped together as the two species were not separately identified during those surveys.

Table 3. Frequency of observation (% of transects) of marine birds observed in the three sections of Dixon Entrance, 1981-1984.

Bird categories	Mouth				Channel					East			
	Apr 84	May 81	July 81	Oct 84	Jan 84	Apr 84	May 83	July 83	Oct 84	Apr 84	June 83	July 83	Oct 84
Gaviidae (loons)	6	22	6	30	0	17	10	0	22	0	6	0	21
Diomedeidae													
Black-footed Albatross	19	20	37	10	6	0	0	19	6	0	0	0	3
Procellaridae													
Sooty Shearwater	22	92	17	45	0	13	55	62	14	29*	6	75	62
Northern Fulmar	0*	0	25	25	0	0*	5	69	18	0*	0	58	21
Hydrobatidae													
Fork-tailed Storm-Petrel	0	8	33	5	0	0	3	19	6	0	56	92	0
Leach's Storm-Petrel	0	0	0	5	0	0	3	0	6	0	0	8	0
Phalacrocoracidae (cormorants)	3	3	4	10	0	3	0	0	4	6	11	0	0
Anseriformes (mostly White-winged Scoters)	0*	2	0	15	0	6*	7	0	22	41	6	0	17
Scolopacidae (shorebirds)	0	2	2	0	0	1	5	6	0	0	0	42	3
Laridae													
Glaucous-winged Gull	12	5	40	0	13	30*	17	0	8	23	22	33	10
Herring Gull	47	47	46	60	13	56*	72	50	82	53	66	83	72
Thayer's Gull	6			25	10	14			8	23*			0
Black-legged Kittiwake	0*	0	0	25	3	0*	15	0	30	0*	6	0	41
Unid. large gulls	3	0	0	20	10	3	0	0	26	18	28	0	31
Miscellaneous gulls	0	0	0	5	3	11	0	19	0	0	0	0	13
Alcidae													
Common Murre	12	18	0	5	3	9*	12	19	18	53	11	50	45
Thick-billed Murre	0	0	0	0	0	0	0	0	0	0	0	0	10
Rhinoceros Auklet	34	70	60	10	0	19*	52	31	0	35*	56	75	0
Cassin's Auklet	25	70	44	5	0	3	22	50	0	0	0	17	3
Ancient Murrelet	25*	67	12	0	0	48*	62	6	0	53*	0	0	0
Unid. and misc. alcids	34	2	2	20	0	16	10	12	10	12	22	17	7
Unid. and misc. birds	6	0	2	10	0	0	0	12	0	0	6	8	0

* Significantly different frequency between April and October within sections. Tested only for those months as surveys then included all of Dixon Entrance.

Cormorants, mostly Pelagic Cormorants (Phalacrocorax pelagicus) but also Double-crested Cormorants (P. auritus), were sighted infrequently.

White-winged Scoters were most frequently observed in the east section in April. Of a total of 1057 Anseriformes seen, 80 percent were White-winged Scoters, and 9 percent Black (Melanitta nigra) and Surf (M. perspicillata) Scoters. Canada Geese (Branta canadensis) and a variety of dabbling and diving duck species comprised the remaining 11 percent.

Shorebirds were never numerous during any survey . Of a total of 39 shorebirds counted, 21 were Red-necked Phalaropes (Phalaropus lobatus) and 18 were unidentified small sandpipers.

Glaucous-winged Gulls (Larus glaucescens) were common anywhere, but were always far outnumbered by Herring Gulls (Tables 2 and 3). Thayer's Gulls (Larus thayeri) were also few, and were mostly seen in October, January and April. Black-legged Kittiwakes (Rissa tridactyla) occurred most frequently in October. Of 24 miscellaneous gulls observed in Dixon Entrance, 18 were Glaucous (Larus hyperboreus), 3 Sabine's (Xema sabini) and 3 Mew Gulls (Larus canus).

Common Murres (Uria aalge) were found in each month in all sections (with the exception of July in the mouth section). They were most frequently observed in the east section, while Thick-billed Murres (U. lomvia) were only recorded in October in that section (Tables 2 and 3). Rhinoceros Auklets occurred frequently in all sections, except in January and October. Cassin's Auklets were most frequently observed in spring and summer, at the mouth of Dixon Entrance. Ancient Murrelets were abundant in all sections in April and May, but few were seen at other times. Of a total of 126 unidentified and miscellaneous alcids observed, there were 8 Tufted Puffins (Fratercula cirrhata), 5 Pigeon Guillemots (Cepphus columba), 9 Marbled Murrelets (Brachyramphus marmoratus), 6 Parakeet Auklets (Cyclorrhynchus psittacula) and 98 unidentified alcids.

Seabird density (Table 4) generally reflected changes in numbers (Table 2) and frequency of observation (Table 3).

3. Seabird standing stock

Standing stock of seabirds was highest at the mouth of Dixon Entrance in May 1981; there were 93,477 birds, of which Ancient Murrelets made up 47 percent (Table 5). The two next-highest standing stocks occurred in the channel (May, 1983) and east sections (April 1983) - with 40,989 and 40,796 birds, respectively - of these totals, murrelets constituted 64 and 46 percent. Ancient Murrelets also made up 74 percent of the standing stock of 21,386 birds in the channel area in April 1984. Clearly, this species represented by far the most important bird component in Dixon Entrance.

The second most numerous species was the Cassin's Auklet (Table 5). Cassin's Auklets made up 28 percent of the standing stock of 93,477 birds in May 1981 and had the largest stock in the mouth section in July 1981. Sooty Shearwaters, Forktailed Storm-Petrels, Rhinoceros Auklets and White-winged Scoters also constituted important components of the seabird standing stock in Dixon Entrance (Table 5).

Table 4. Density of marine birds (number/100km^2) observed in the three sections of Dixon Entrance, 1981-1984.

Bird categories	Mouth				Channel					East			
	Apr 84	May 81	July 81	Oct 84	Jan 84	Apr 84	May 83	July 83	Oct 84	Apr 84	June 83	July 83	Oct 84
Gaviidae (loons)	1.5	12.6	1.8	5.8	0	5.2	2.7	0	4.2	0	1.1	0	4.5
Diomedeidae													
Black-footed Albatross	0.9	1.8	3.3	0.3	0.4	0	0	0.7	0.3	0	0	0	0.1
Procellaridae													
Sooty Shearwater	12.0	378.6	10.0	29.8	0	15.1	51.0	16.5	4.2	15.3	1.1	40.9	48.0
Northern Fulmar	0	0	11.7	3.6	0	0	1.3	22.0	4.5	0	0	11.4	7.3
Hydrobatidae													
Fork-tailed Storm-Petrel	0	149.1	221.5	3.3	0	0	4.0	16.5	40.6	0	83.8	439.7	0
Leach's Storm-Petrel	0	0	0	3.3	0	0	2.0	0	14.9	0	0	5.1	0
Phalacrocoracidae (cormorants)	0.5	1.9	2.9	1.5	0	0.7	0	0	1.8	4.0	2.2	0	0
Anseriformes (mostly White-winged Scoters)	0	0.5	0	12.4	0	5.0	7.5	0	38.2	684.4	1.1	0	11.9
Scolopacidae (shorebirds)	0	21.0	26.4	0	0	2.0	47.9	66.0	0	0	0	81.8	5.1
Laridae													
Glaucous-winged Gull	3.5	2.3	13.5	0	3.8	6.3	4.0	0	4.5	6.4	5.5	5.7	2.2
Herring Gull	39.6	19.6	22.3	36.4	3.0	19.0	19.5	14.7	46.5	12.9	47.1	13.6	64.9
Thayer's Gull	1.0			3.6	2.2	2.2			1.2	3.2			0
Black-legged Kittiwake	0	0	0	7.6	1.1	0	14.0	0	10.8	0	3.3	0	93.2
Unid. large gulls	0.5	0	0	10.9	2.3	1.3	0	0	6.3	8.9	5.5	0	158.1
Miscellaneous gulls	0	0	0	0.7	2.2	3.2	0	2.8	0	0	0	0	2.6
Alcidae													
Common Murre	9.0	22.4	0	1.1	1.1	3.9	5.3	5.5	9.0	32.6	6.6	11.9	46.7
Thick-billed Murre	0	0	0	0	0	0	0	0	0	0	0	0	9.3
Rhinoceros Auklet	40.6	297.3	79.1	11.4	0	14.3	41.9	22.7	0	81.5	46.8	51.1	0
Cassin's Auklet	189.5	1054.6	290.1	3.3	0	5.9	87.9	123.8	0	0	0	20.4	137.2
Ancient Murrelet	349.7	1773.1	89.7	0	0	323.8	532.7	4.1	0	757.2	0	0	0
Unid. and misc. alcids	84.6	4.2	1.3	58.9	0	28.5	15.0	6.2	3.4	25.4	17.3	10.2	17.8
Unid. and misc. birds	2.3	0	0.6	4.4	0	0	0	1.8	0	0	1.1	3.4	0
Total	735.2	3739.0	774.2	198.3	16.1	436.4	836.7	303.3	190.4	1631.8	222.5	695.2	602.9

Table 5. Standing stock of marine birds observed in the three sections of Dixon Entrance, 1981-1984.

Bird categories	Mouth				Channel					East			
	Apr 84	May 81	July 81	Oct 84	Jan 84	Apr 84	May 83	July 83	Oct 84	Apr 84	June 83	July 83	Oct 84
Gaviidae (loons)	38	315	44	145	0	257	130	0	206	0	27	0	112
Diomedeidae													
Black-footed Albatross	21	45	82	9	18	0	0	17	14	0	0	0	4
Procellaridae													
Sooty Shearwater	301	9,465	249	745	0	739	2,498	412	221	382	27	1,022	1,200
Northern Fulmar	0	0	293	91	0	0	65	550	206	0	0	284	183
Hydrobatidae													
Fork-tailed Storm-Petrel	0	3,729	5,538	82	0	0	195	412	1,989	0	2,096	10,922	0
Leach's Storm-Petrel	0	0	0	82	0	0	98	0	729	0	0	128	0
Phalacrocoracidae (cormorants)	12	47	73	36	0	32	0	0	88	101	55	0	0
Anseriformes (mostly White-winged Scoters)	0	12	0	309	0	247	369	0	1,871	17,110	27	0	297
Scolopacidae (shorebirds)	0	525	659	0	0	96	2,346	1,650	0	0	0	2,045	127
Laridae													
Glaucous-winged Gull	88	58	337	0	184	311	196	0	221	161	137	142	55
Herring Gull	990	490	557	909	147	932	956	367	2,283	322	1,178	341	1,623
Thayer's Gull	25			91	110	107			59	81			0
Black-legged Kittiwake	0	0	0	191	55	0	684	0	530	0	82	0	2,330
Unid. large gulls	12	0	0	273	110	64	0	69	309	221	137	0	3,952
Miscellaneous gulls	0	0	0	18	110	155	0	0	0	0	0	0	67
Alcidae													
Common Murre	226	560	0	27	55	193	261	137	442	815	164	298	1,017
Thick-billed Murre	0	0	0	0	0	0	0	0	0	0	0	0	233
Rhinoceros Auklet	1,015	7,432	1,978	286	0	699	2,053	567	0	2,038	1,171	1,278	0
Cassin's Auklet	4,738	26,366	7,252	82	0	289	4,302	3,094	0	0	0	511	3,430
Ancient Murrelet	8,743	44,328	2,242	0	0	15,867	26,103	103	0	18,931	0	0	0
Unid. and misc. alcids	2,115	105	33	1,473	0	1,398	733	155	166	634	432	256	445
Unid. and misc. birds	56	0	15	109	0	0	0	46	0	0	27	85	0
Total	18,380	93,477	19,352	4,958	789	21,386	40,989	7,579	9,334	40,796	5,560	17,312	15,075

4. Comparison of overall seabird populations between spring and autumn.

All three sections of Dixon Entrance were surveyed both in April and in October 1984. Bird populations at those times therefore lend themselves to comparison of seabird use for the whole region. Seabird standing stock in April was at least twice that in October, mostly as a result of the presence of Ancient Murrelets. This species comprised 57 percent of the standing stock of 69,593 birds seen in April; none were seen in October (Table 6). Large gulls, particularly Herring Gulls, made up 44 percent of the standing stock in October but only 5 percent in April. Herring Gulls occurred significantly more in October than in April, while the reverse was observed for Glaucous-winged Gulls (Table 6). Other major differences were that no Northern Fulmars, Fork-tailed and Leach's Storm-Petrels, Black-legged Kittiwakes or Thick-billed Murres were recorded in April, while those species (particularly the Fork-tailed Storm-Petrels and Black-legged Kittiwakes) constituted 23 percent of the standing stock in October.

5. Numbers and occurrence of seabirds over waters less and deeper than 180 m in April and October, 1984

Black-footed Albatross was the only species which occurred significantly more in waters deeper than 180m, while cormorants, White-winged Scoters, Black-legged Kittiwakes, Common Murres and Ancient Murrelets occurred significantly more in waters less than 180m deep (Table 7).

DISCUSSION

1. Comparison with Hecate Strait and Queen Charlotte Sound

The distribution and magnitude of pelagic seabird populations in Hecate Strait and Queen Charlotte Sound have recently been extensively discussed by the authors (Vermeer and Rankin 1984). That discussion will not be repeated here and the reader is referred to it for an explanation of seasonal trends and movements of pelagic birds in waters of northern British Columbia. We will briefly emphasize here similarities between seabird trends in Dixon Entrance and those in Hecate Strait and Queen Charlotte Sound.

Bird densities per 100 km^2 in Dixon Entrance ranged from 20 birds in January to 70 in April, to 80 to 370 in May, to 70 in July, and to 30 in October (Tables 5 and 6). Densities were therefore highest in May and lowest in January. A similar seasonal trend of bird densities was observed in Hecate Strait and Queen Charlotte Sound (Vermeer and Rankin 1984). Alcids, specifically Ancient Murrelets and Cassin's Auklets, contributed to most of the standing stock in Dixon Entrance during the 1981-1984 period. Those two species, together with Sooty Shearwaters, also were found to comprise much of the seabird standing stock in Hecate Strait and Queen Charlotte Sound (Vermeer and Rankin 1984).

Sooty Shearwaters were found to be less numerous in Dixon Entrance than in the Strait and Sound, this fact may result from observational bias. Sooty Shearwaters commonly travel in flocks of tens of thousands of birds. Such flocks were occasionally seen in the Strait and Sound, but not in Dixon Entrance. Observation of just one flock of 10,000 shearwaters in Dixon Entrance would have made the Sooty Shearwater the most numerous species there.

Table 6. Numbers, frequency of observation (% of transects), density per 100 km^2, and standing stock of marine birds observed in Dixon Entrance, April and October 1984.

Bird categories	April				October			
	Numbers	Freq. observ.	Density	Standing stock	Numbers	Freq. observ.	Density	Standing stock
Gaviidae (loons)	27	9	3.3	342	30	22	4.6	459
Diomedeidae								
Black-footed Albatross	7	5	0.2	22	7	6	0.3	27
Procellaridae								
Sooty Shearwater	112	18	14.3	1,420	140	39*	21.6	2,141
Northern Fulmar	0	0	0	0	33	18*	5.1	505
Hydrobatidae								
Fork-tailed Storm-Petrel	0	0	0	0	31	4	21.6	2,134
Leach's Storm-Petrel	0	0	0	0	12	4	8.3	826
Phalacrocoracidae (cormorants)	9	3	1.1	114	8	4	1.2	122
Anseriformes (mostly White-winged Scoters)	873	9	112.0	11,068	165	19	25.5	2,524
Scolopacidae (shorebirds)	1	1	1.2	114	1	1	1.4	138
Laridae								
Glaucous-winged Gull	44	25	5.6	558	19	7*	2.9	290
Herring Gull	182	53	23.3	2,308	320	75*	49.4	4,894
Thayer's Gull	16	14	2.0	203	9	9	1.4	138
Black-legged Kittiwake	0	0	0	0	141	32*	32.7	3,235
Unid. large gulls	18	5	2.3	228	316	26	48.8	4,833
Miscellaneous gulls	14	7	1.9	184	5	5	1.0	100
Alcidae								
Common Murre	51	16	9.8	970	69	22	16.9	1,675
Thick-billed Murre	0	0	0	0	11	10	9.3	161
Rhinoceros Auklet	110	25	31.7	3,138	7	2*	2.4	241
Cassin's Auklet	45	8	51.9	5,135	28	2	38.9	3,854
Ancient Murrelet	693	42	399.4	39,538	0	0*	0	0
Unid. and misc. alcids	78	18	42.4	4,194	28	9	19.1	1,892
Unid. and misc. birds	3	2	0.6	57	6	2	1.4	138
Total	2,283		703.0	69,593	1,386		313.8	30,327

* Significantly different in frequency between April and October ($p<0.05$).

Table 7. Comparison of numbers and frequency of observation (% of transects) of marine birds in Dixon Entrance over waters shallower or deeper than 180m, April and October 1984.

Bird categories	April				October			
	Numbers		Freq. observ.		Numbers		Freq. observ.	
	<180m	>180m	<180m	>180m	<180m	>180m	<180m	>180m
Gaviidae (loons)	6	21	6	16	10	20	22	23
Diomedeidae								
Black-footed Albatross	0	7	0	9*	2	5	3	8
Procellaridae								
Sooty Shearwater	72	40	18	18	59	81	16	19
Northern Fulmar	0	0	0	0	10	23	43	37
Hydrobatidae								
Fork-tailed Storm-Petrel	0	0	0	0	0	31	0	8
Leach's Storm-Petrel	0	0	0	0	1	11	3	5
Phalacrocoracidae (cormorants)	9	0	8	0*	8	0	6	0
Anseriformes (mostly White-winged Scoters)	864	9	16	4*	75	90	19	19
Scolopacidae (shorebirds)	0	1	0	1	1	0	3	0
Laridae								
Glaucous-winged Gull	18	26	22	27	2	17	3	10
Herring Gull	64	118	51	55	140	180	68	79
Thayer's Gull	12	4	18	6	0	9	0	14
Black-legged Kittiwake	0	0	0	0	118	23	46	24*
Unid. large gulls	18	0	12	0	259	57	22	29
Miscellaneous gulls	6	8	4	9	4	1	10	2
Alcidae								
Common Murre	34	17	18	15	62	12	35	16*
Thick-billed Murre	0	0	0	0	6	0	0	10
Rhinoceros Auklet	80	30	31	22	4	3	3	2
Cassin's Auklet	9	36	4	12	28	0	5	0
Ancient Murrelet	581	112	57	31*	0	0	0	0
Unid. and misc. alcids	55	23	23	18	0	28	0	14
Unid. and misc. birds	1	2	2	3	0	6	0	3
Total number	1,829	454			789	597		

* Significantly different in occurrence between water <180m and >180m.

As in Dixon Entrance, large gulls, particularly Herring Gulls, have been found to form an important component of the standing stock in the Strait and Sound in autumn (Vermeer and Rankin 1984). White-winged Scoters were also the most numerous anatids in the Strait and Sound, as they were in Dixon Entrance. Other similarities between Dixon Entrance and the Strait and Scund include the occurrence of Black-footed Albatross in deep waters, of Sooty Shearwaters in either deep or shallow waters and of cormorants, scoters and murres in shallow waters.

In summary, there are many similarities in the distribution and seasonal changes in seabird populations of Dixon Entrance and those of Hecate Strait and Queen Charlotte Sound. The major difference was that Sooty Shearwaters were observed to be a more important component in the Strait and Sound than in Dixon Entrance. However, this fact may be due to an observational bias, as pointed out above.

2. Comparison of seabird numbers on transects with those in nesting colonies in the Dixon Entrance region

Ancient Murrelets and Cassin's Auklets were generally most numerous in Dixon Entrance in April and May (Tables 2-5). During this period, these species nest near the Entrance mouth. Ancient Murrelets comprised 49.9 percent, and Cassin's Auklets 45.6 percent, of seabirds nesting in the area between Frederick Island to Langara Island (northwestern Graham Island - Fig. 3). Ancient Murrelets stage near their colonies, mostly during the second half of May and the early part of June, while Cassin's Auklets do not. Both species feed extensively at the shelfbreak, while Cassin's Auklets also concentrate over banks and seamounts (Vermeer et al. 1985).

Leach's Storm-Petrels formed by far the largest component of seabirds nesting on Forrester Island; southeastern Alaska (Fig. 3). That relatively few Leach's Storm-Petrels were seen in Dixon Entrance is not surprising since they forage chiefly far offshore (eg. Vermeer and Rankin 1984, Martin and Myres 1969).

Rhinoceros Auklets and Tufted Puffins are numerous nesting alcids on Forrester Island, (Sowls et al. 1978). Rhinoceros Auklets seen at the mouth of Dixon Entrance during spring and summer may nest on nearby Forrester Island, while those seen in the east section may be derived from Forrester as well as from Lucy Island. This latter island is located in Chatham Sound, east of Dixon Entrance (it is not shown in Fig. 3): it is known to contain the other large Rhinoceros Auklet colony in the Dixon Entrance region. Relatively few Tufted Puffins, close relatives of the Rhinoceros Auklet, were seen in Dixon Entrance, perhaps as puffins remain closer to their nesting colony than do Rhinoceros Auklets when raising their young (Vermeer 1979).

In summary, the large numbers of Ancient Murrelets and Cassin's Auklets seen in Dixon Entrance in April and May may reflect the presence of large nesting colonies of the two species near the mouth.

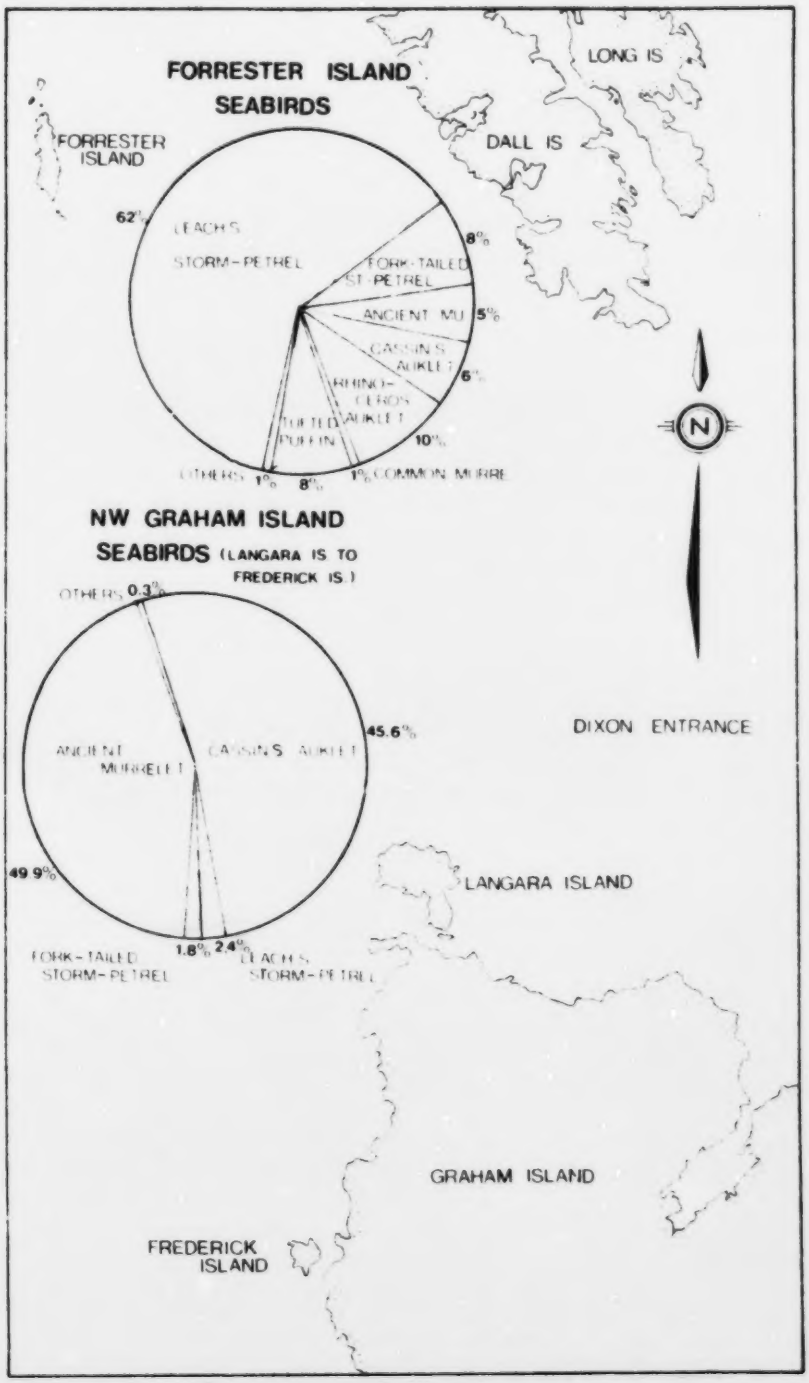

Figure 3. Breeding populations of seabirds near the mouth of Dixon Entrance: 1,070.000 birds on Forrester Island (Sowls et al. 1978), and 377,000 birds at NW Graham Island (Vermeer, unpubl. data).

RECOMMENDATIONS

The present study indicates that seabirds are most numerous in Dixon Entrance in April and May. It is to be noted that large numbers of birds could be affected during this period by oil spills and other environmental disturbances resulting from exploratory and production drilling within Dixon Entrance. At least exploratory drilling is possible within the near future. Ancient Murrelets, in particular, would be vulnerable during the second half of May and the beginning of June at which time they stage by the tens of thousands near the Frederick and Langara Island colonies (Vermeer et al. 1984). No offshore drilling should take place in the vicinity of those colonies during the nesting period.

The present study, like that in Hecate Strait and Queen Charlotte Sound (Vermeer and Rankin 1984), could not include a systematic survey of Dixon Entrance as the observers involved had no control over the ship's course. Since the area of Dixon Entrance is much less than that of Hecate Strait - Queen Charlotte Sound, it would be relatively inexpensive to conduct thorough systematic surveys. It is suggested that such surveys be conducted before offshore drilling operations take place. Since most seabirds probably concentrate in Dixon Entrance for feeding purposes, studies of the birds' diet and preferred feeding localities, as well as of the life cycle of major prey species, should be investigated in conjunction with the surveys. Our 1981-84 investigation did not allow for the active pursuit of food studies with one exception: in 1981, the feeding locations of Ancient Murrelets and Cassin's Auklets were investigated in the Entrance mouth using a chartered vessel (Vermeer et al. 1985). Ancient Murrelets and Cassin's Auklets are mostly planktivorous, and feed on the same plankton species as do baleen whales along the British Columbia coast (J. Fulton, pers. comm.). During these surveys baleen whales, including the now rare blue whale (Sibbaldus musculus) were occasionally seen at the mouth of Dixon Entrance. Perhaps the presence of the blue whales occurred because the area is rich in euphausiids, which form the main diet of that species (Cowan and Guiguet 1975).

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Appendix

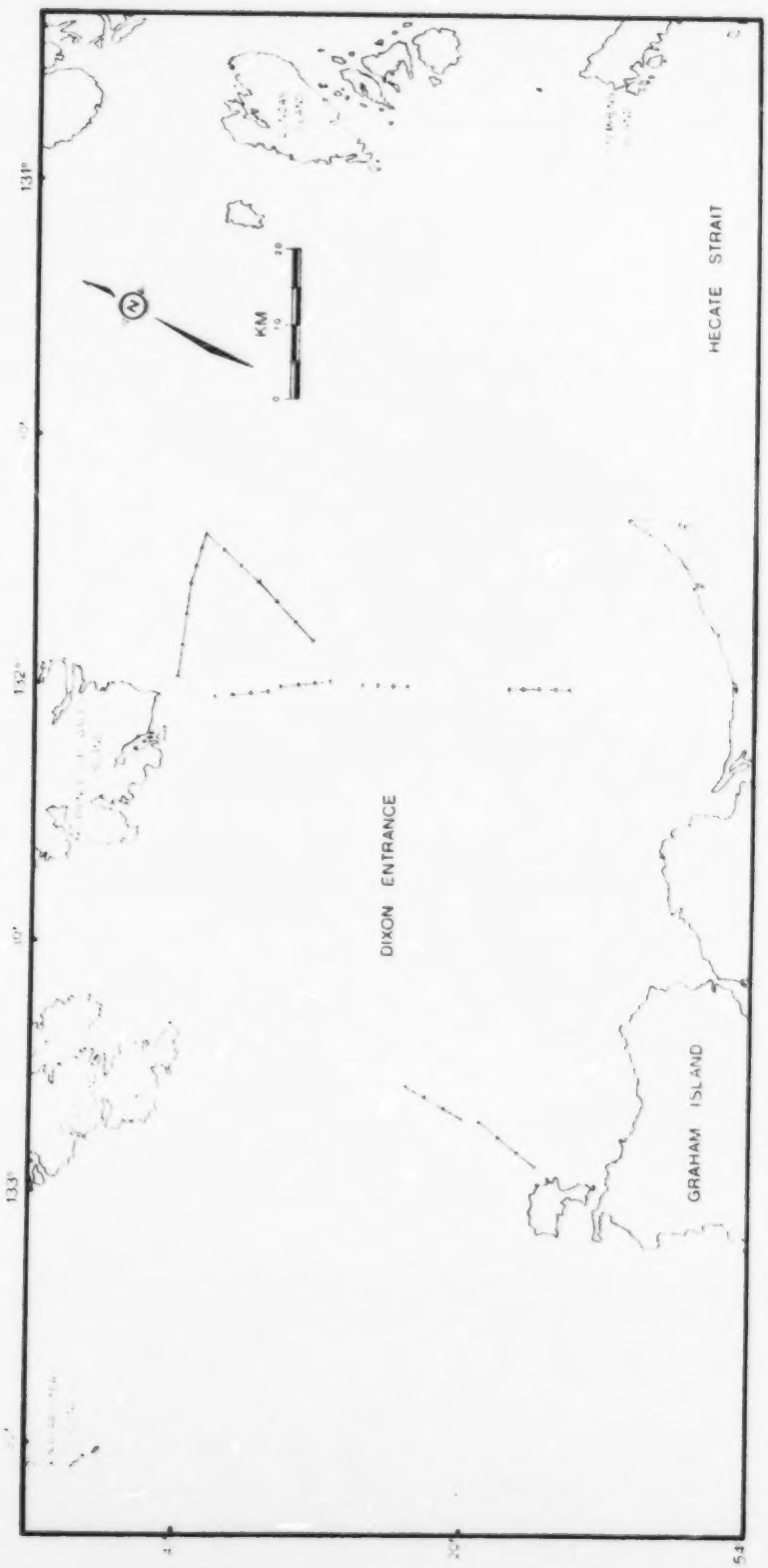

Figure 1. Location of survey transects in Dixon Entrance, January 1984.

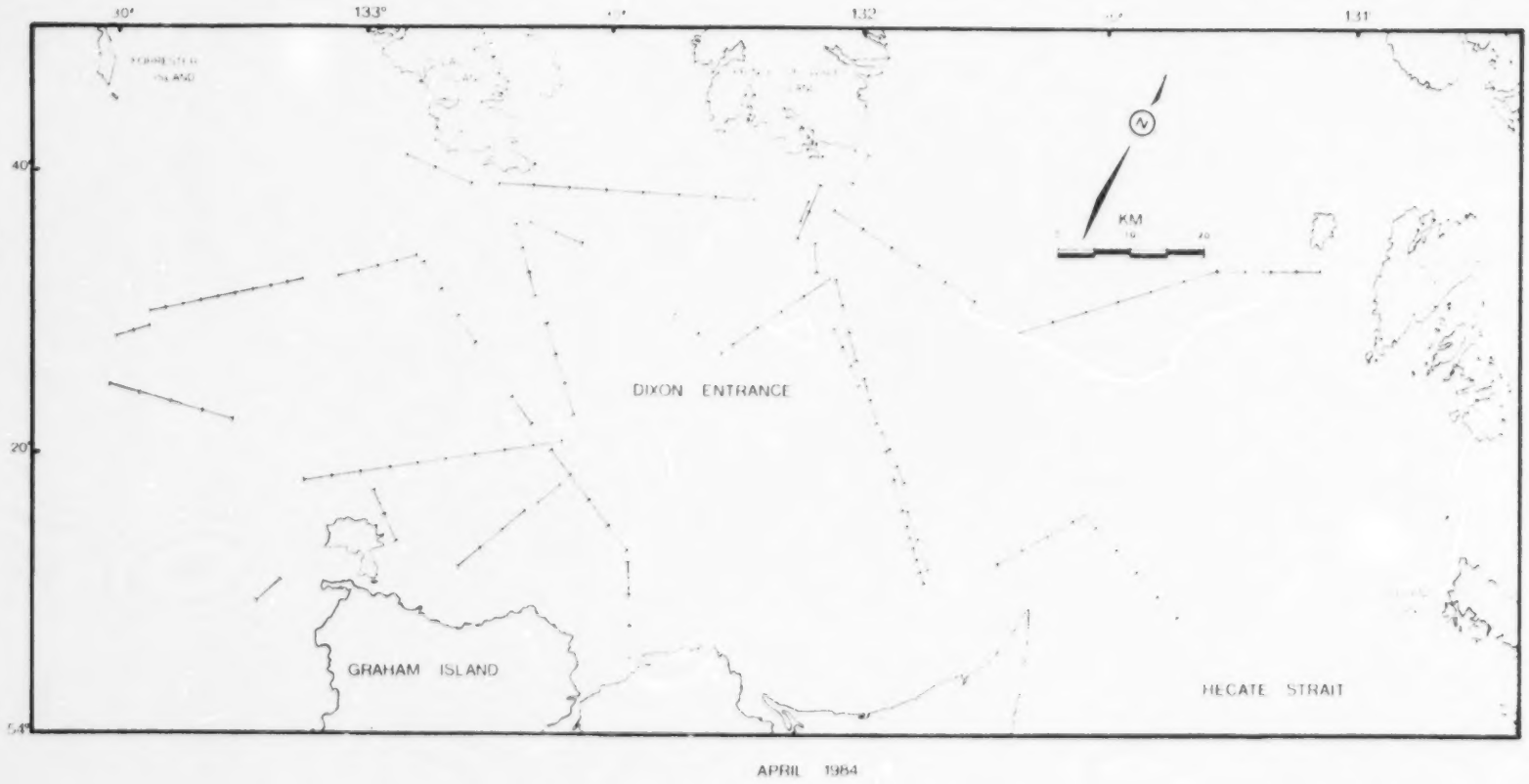

Figure 2. Location of survey transects in Dixon Entrance, April 1984.

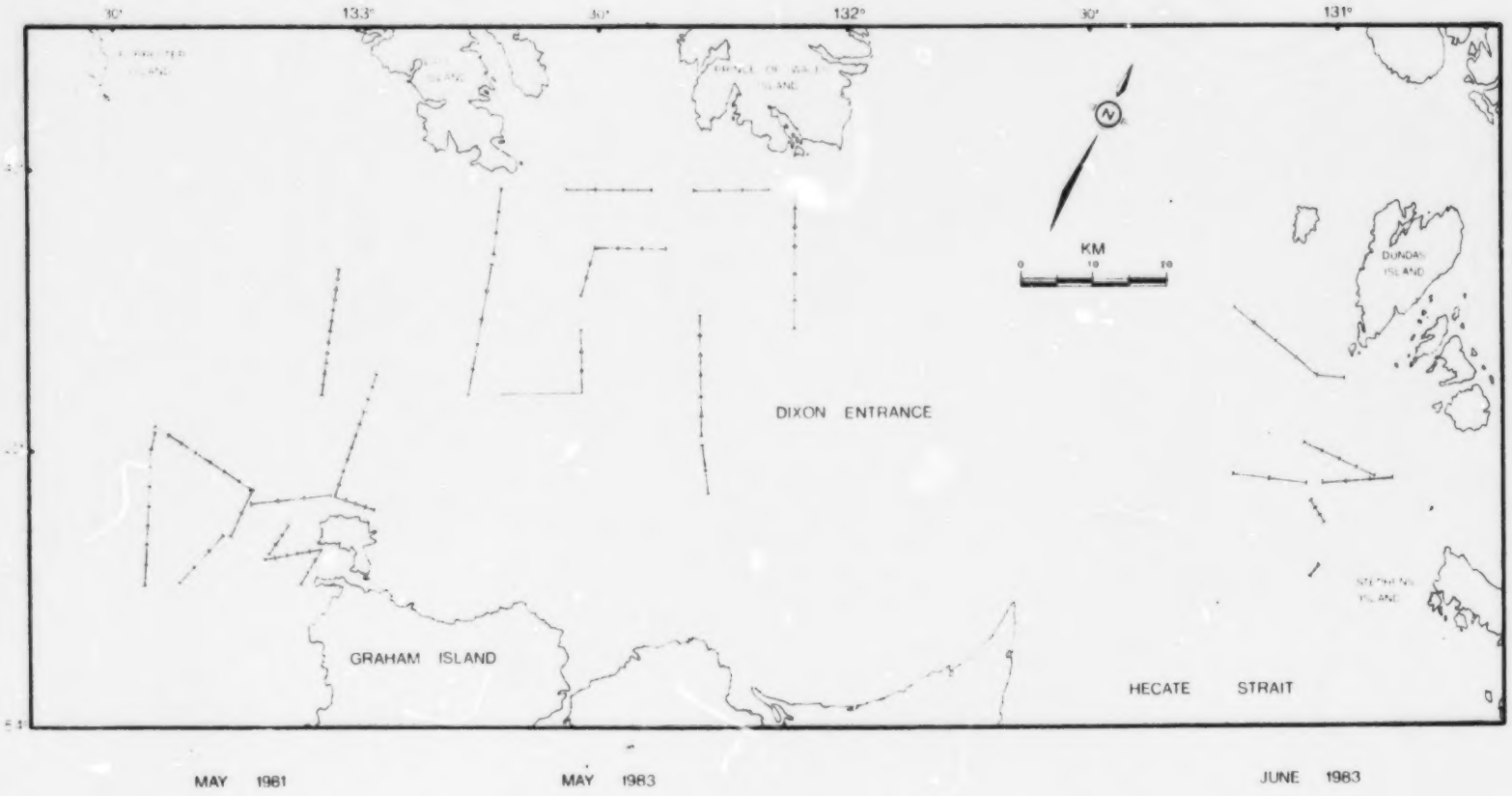

Figure 3. Location of survey transects in Dixon Entrance, May 1981 and May and June 1983.

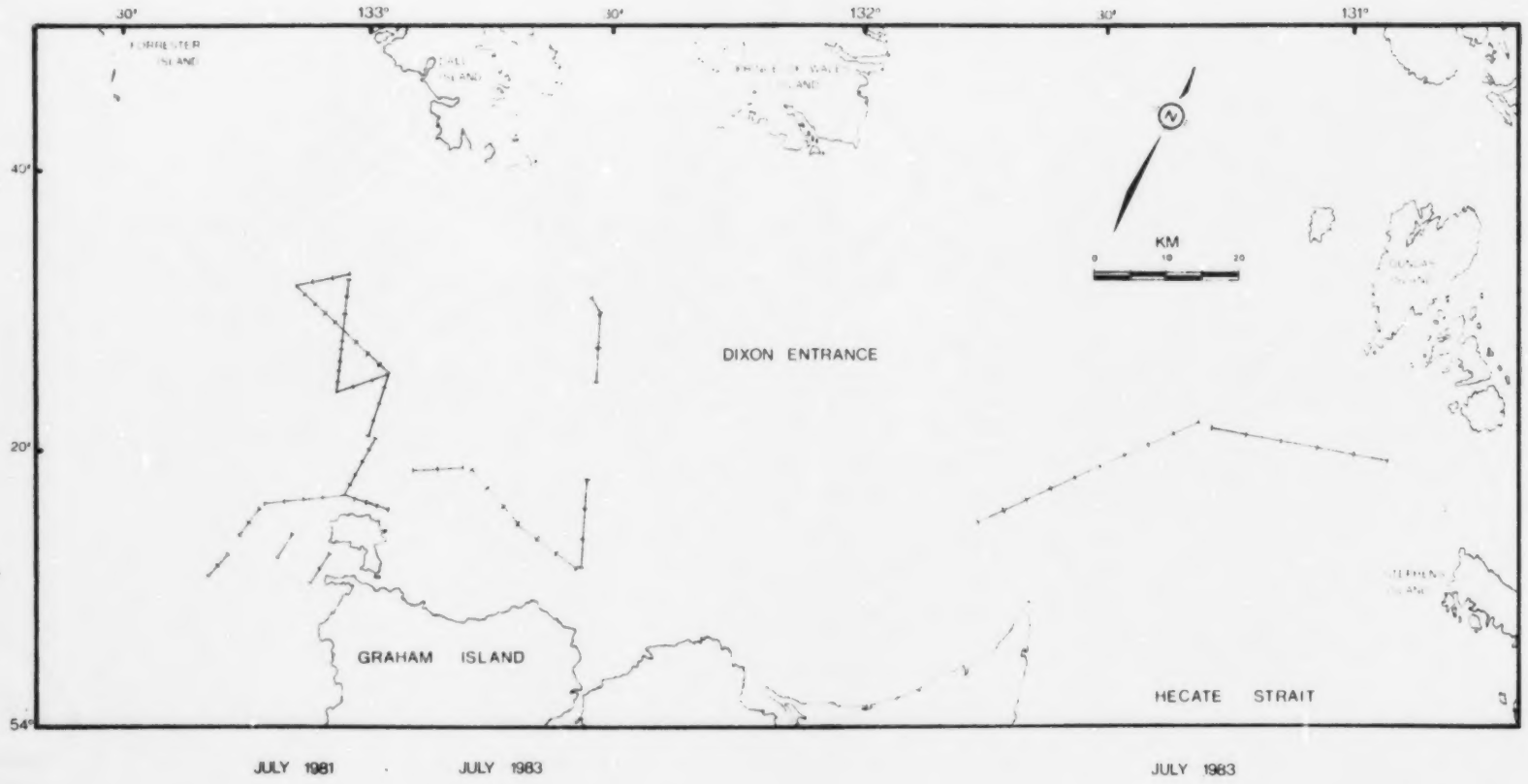

Figure 4. Location of survey transects in Dixon Entrance, July 1981 and 1983.

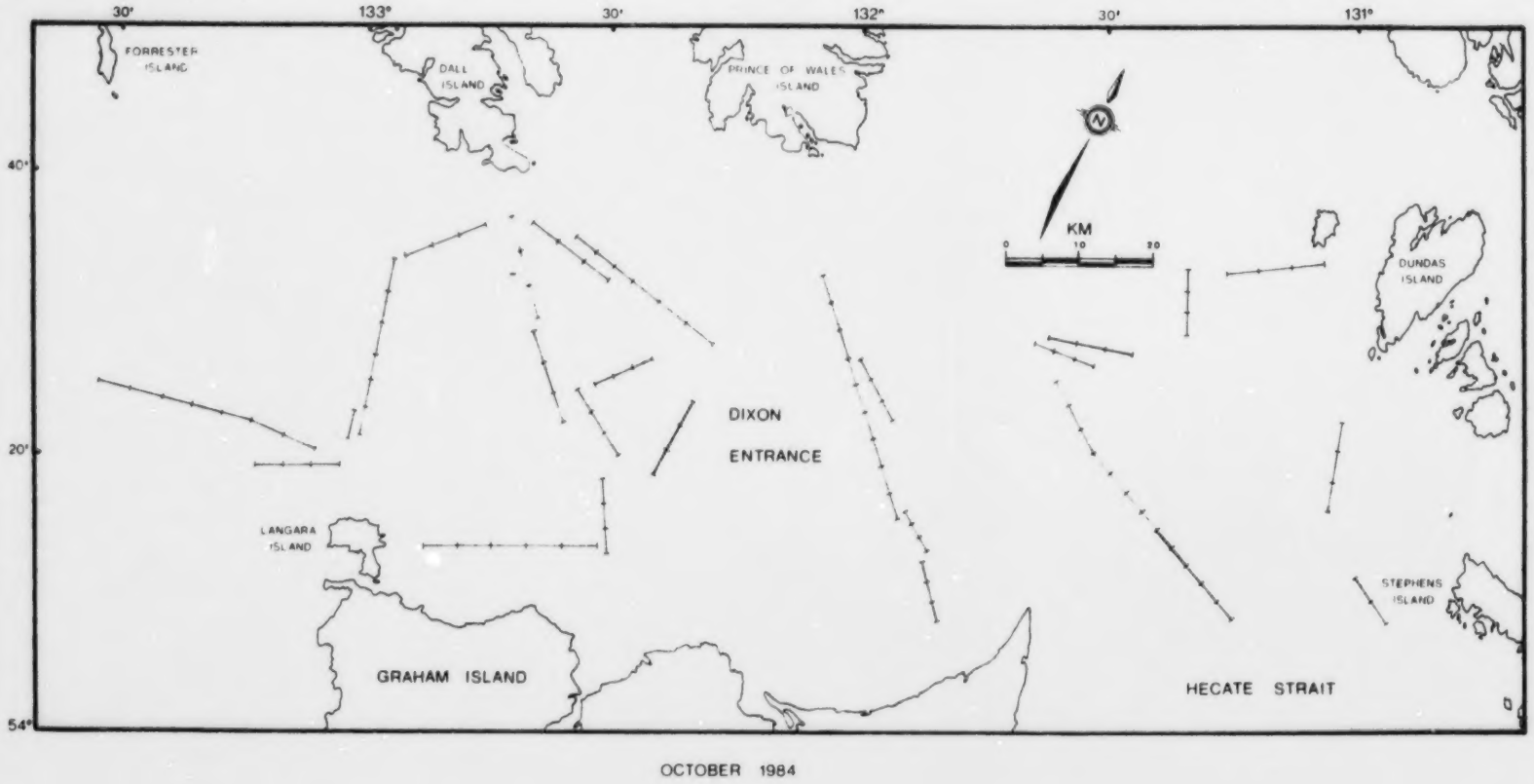

Figure 5. Location of survey transects in Dixon Entrance, October 1984.